

IN THE DRAWINGS:

Attached to the English translation of the PCT document, are translated legends for Figures 1, 2, 3, 4, 5, and 6, all identified as "Replacement Sheet".

R E M A R K S

The specification has been amended in accordance with U.S. practice.
An Abstract also has been added.

New claims are presented based on the PCT prosecuted claims but
5 written U.S. format. A Substitute Specification and marked copy of Substitute
Specification are enclosed.

An Information Disclosure Statement is enclosed.

Respectfully Submitted,



(Reg. 27,841)

10

Schiff, Hardin LLP
CUSTOMER NO. 26574
Patent Department
6600 Sears Tower
233 South Wacker Drive
Chicago, Illinois 60606
Telephone: 312/258-5786
15 Attorneys for Applicant.

CHI\4647165.1

MARKED-UP PCT/PTO
AP20 Rec'd PCT/PTO 02 AUG 2006**SPECIFICATION****TITLE****CONTROL DEVICE AND METHOD FOR CONTROLLING AN ELECTROPHOTOGRAPHIC PRINTER OR COPIER**

5

BACKGROUND

The present invention preferred embodiment of the invention concerns a method for controlling an electrophotographic printer or copier that has at least one developer station for development of a latent charge image on a photoconductor with toner. It also concerns a control device for such a printer
10 or copier.

Known methods of the aforementioned type typically provide different operating states or operating modes that the printer or copier can adopt in operation. Examples for such operating states are a standby mode in which the functional voltages and currents of the developer stations that are
15 necessary for developing of charge images are typically deactivated and the mechanical actuators of the developer station are stopped. Such a standby mode is typically adopted when the printer or copier is turned on but no print data is present.

A further typical operating state is the print operation mode in which
20 typically all functional voltages and currents of the developer stations are switched to nominal parameters and all actuators run with nominal parameters. Such a print operation mode is typically started as soon as print data are present and is maintained as long as the print data are present. During this print operation, as stated the actuators of all developer stations
25 run in normal operation, meaning that all mixing devices (such as bucket wheels, paddlewheels, mixing dredgers and the like) for stirring the developer and all devices for applying the developer from the developer station onto the photoconductor are in operation during the print operation mode.

During such a print operation it can occur that one or more developer stations has only a very small toner discharge or even no toner discharge at all for a longer time period. In the present document, either a mixture of toner
30

MARKED-UP COPY

and carrier particles or a one-component developer is meant with the term "developer". In the case of the one-component developer, the terms "developer" and "toner" designate the same thing. The case of slight or disappearing toner discharge occurs relatively frequently in color printers or

5 copiers in which a separate developer station is provided for each color component (cyan, yellow, magenta and black) and in fact when the print data do not contain a color component or contain a color component to only a limited extent for a longer time period. A prolonged low toner discharge can, however, also occur in one-color printers, namely when a plurality of
10 successive print pages with little content is printed.

It has been shown that the developer ages or, respectively, is damaged relatively quickly with prolonged low toner discharge, i.e. wears in the developer station and leads only to poor print results. In the case that a developer station is not required for a longer time period during the print
15 operation, it is itself additionally subjected to an unnecessary wear.

SUMMARY

~~The invention is based on the~~ It is an object to specify a method and a control device of the aforementioned type that ~~or, respectively, which~~ reduces the wear of the developer and/or of the apparatus.

20 In a method or system for controlling an electrophotographic printer or copier that has at least one developer station, a toner discharge from the developer station is detected during the print operation and a developer regeneration process is started when the detected toner discharge fulfills a predetermined first regeneration criterion. A charge image is generated on the photoconductor, the charge image is developed by the developer station, and the developed image is removed by a cleaning device without being transferred as printed onto a recording medium. New toner is introduced into the developer station. Also in accordance with the method or system for controlling an electrophotographic printer or copier that has at least two developer stations, during a print operation the print data is used to determining which developer stations are needed for printing of the data. In

25

30

MARKED-UP COPY

the event it is established that a developer station was not needed or will not be needed, the developer station is shifted into a standby state in which at least one part of mechanical actuators of the developer station is stopped.

BRIEF DESCRIPTION OF THE DRAWINGS

5 Figure 1 is a block diagram that shows the components of a method according to a development of the invention;

Figure 2 is a flow diagram that shows a method for evaluation of the toner discharge;

10 Figure 3 is a flow diagram that shows a method for administration of states of a developer station;

Figure 4 is a flow diagram that shows a method for standby administration;

Figure 5 is a flow diagram that shows the temporal synchronization of developer regeneration processes given a plurality of developer stations of a printer;

Figure 6 is a flow diagram that shows the integration of a method according to a development of the invention into a conventional method for controlling a printer; and

Figure 7 is a section representation of a printer is

20 **DESCRIPTION OF THE PREFERRED EMBODIMENT**

This object is achieved according to a first aspect of the invention via a method with the features of the claim 1 and via a control device with the features of the claim 26. This object according to a second aspect of the invention is also achieved via a method with the features of the claim 14 and via a control device with the features of the claim 38. However, in an advantageous development both aspects can be unified in a common method or, respectively, a single control device. Advantageous developments are specified in the dependent claims.

MARKED-UP COPY

For the purposes of promoting an understanding of the principles of the invention, reference will now be made to preferred embodiment illustrated in the drawings and specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope of the invention is thereby intended, such alterations and further modifications in the illustrated device, and such further applications of the principles of the invention as illustrated therein being contemplated as would normally occur to one skilled in the art to which the invention relates.

In the method according to the first aspect of the invention preferred embodiment, the toner discharge from the developer station is detected during the print operation and, for the case that the detected toner discharge fulfills a predetermined first regeneration criterion, a developer regeneration process is started in which a charge image on the photoconductor is generated, the charge image is developed by the developer station and the developed image is removed by a cleaning device without being transfer-printed onto a recording medium, and in which new toner is introduced into the developer station. The regeneration criterion is thereby initially not more narrowly limited; however, it is developed such that it indicates a prolonged low toner discharge.

In the framework of the inventive solution of the preferred embodiment, the developed charge image can be directly removed from the photoconductor by a cleaning device; however, it can also initially be wholly or partially transfer-printed onto an intermediate carrier and be removed from this by a cleaning device. ~~In the claims 1 and 26 it~~ It is deliberately left open whether it is a cleaning device of the photoconductor, of a possibly-used intermediate carrier or of both. It is merely significant that the developed image is neither directly nor indirectly transfer-printed onto a recording medium in the developer regeneration process.

A wear or, ~~respectively~~, a damaging of the developer can thus be prevented via this method in that the toner discharge is monitored, and in that an artificial toner throughput is caused in the developer regeneration process

MARKED-UP COPY

for the case that said the toner discharge is persistently low. For this, in the developer regeneration process an "artificial" or "random" charge image is generated on the photoconductor, the charge image is being developed by the developer station and new toner is introduced into the developer station.

5 The developed image is not transfer-printed onto a recording medium, such so that no recording medium waste arises. Instead of this the developed image is removed from a cleaning device, as is explained in detail below.

The first regeneration criterion is selected such that it initiates the regeneration process in a timely manner before the developer is damaged or 10 ages, however not unnecessarily early in order to keep the toner waste low and to not unnecessarily interrupt the print operation. Typical properties of the printer or copier and of the developer and empirical values typically enter into the selection of the first regeneration criterion.

In an advantageous development of the method, the toner discharge is 15 determined for time intervals of predetermined length and the first regeneration criterion is fulfilled when the average toner discharge lies below a predetermined threshold for a predetermined number of successive time intervals. Given a suitable length of the intervals, a temporarily-increased toner discharge in a phase with otherwise-low toner discharge that is not 20 sufficient in order to regenerate the developer in the long term is not sufficient in order to raise the average value of the toner discharge over this threshold for this interval. In such a case, the requirement for a regeneration process is furthermore viewed as existing. Contrarily, when the average value of the toner discharge lies above the threshold during one of these intervals, it is 25 assumed that the developer was sufficiently regenerated and it needs no further regeneration process for the time being.

The toner discharge is advantageously determined using print data. The pixel count printed or to be printed is thereby advantageously added up, weighted with its inking level. This represents a (technically) very simple 30 manner to determine the toner discharge from the developer station.

MARKED-UP COPY

When the printer or copier comprises a plurality of developer stations, the toner discharge of each of these developer stations is advantageously detected and, for the case that the developer regeneration process is started for one developer station, it is checked whether the detected toner discharge 5 of the remaining developer stations fulfills a second regeneration criterion, and a developer regeneration process is likewise started for developer stations in which the second regeneration process is fulfilled. The second regeneration criterion indicates that a developer regeneration process is in fact not yet required, however but could be required in the foreseeable future.

10 Since the print operation must be interrupted for every regeneration process, it is advantageous to execute a plurality of regeneration processes in immediate succession in this manner, i.e. to temporally concentrate said that regeneration processes.

The second regeneration criterion can be a weakened or, respectively, 15 less restrictive version of the first regeneration criterion. In connection with the aforementioned advantageous example for the first regeneration criterion, the second regeneration criterion can require that the average toner discharge lies below a predetermined threshold for a predetermined number of successive time intervals that is less than the number of time intervals in the 20 first regeneration criterion.

The method according to the second aspect of the invention preferred embodiment concerns printers or copiers that have at least two developer stations for development of a latent charge image on a photoconductor. According to the second inventive aspect, during the print operation it is 25 determined using the print data which developer stations are necessary for printing of the data, and in the event that it is established that one developer station was not or is not necessary for a predetermined time span this developer station is set into a standby state in which at least one part of the mechanical actuators of the developer station are [sic] is stopped.

30 In this standby state, the mechanical components of the developer station are thus conserved and their wear is reduced. At the same time,

MARKED-UP COPY

developer contained in the developer station is protected because this is damaged or, respectively, aged via a perpetual mixing and activation that is implemented in the print operation. The second aspect is thus closely related with the first aspect of the invention preferred embodiment in terms of content.

5 While the first aspect of the invention preferred embodiment concerns (as described above) a novel special operating state for regeneration and thereby for protection of the developer given prolonged low toner discharge, the second aspect of the invention preferred embodiment concerns a novel special operating state for protection of the developer and of the developer
10 station for the case that the developer station is not required for longer than a predetermined time span.

In the standby state, the developer station is advantageously switched such that no toner transfer can occur between the developer station and the photoconductor, for example via suitable selection of the functional voltages
15 and currents. In an advantageous development, the developer station is swiveled away from the photoconductor in the standby state.

The standby state is advantageously ended when it is established using the print data that the developer station is required for printing of the data. The print data are thereby advantageously, broadly, anticipatorily
20 analyzed so that the time interval between the analysis of the print data and the point in time at which the image corresponding to these data is to be developed by the associated developer station is sufficient in order to shift this developer station from the standby state into the print operation state.

25 Typically, the developer in the developer station must be activated in order to be able to be transferred into the intermediate carrier to develop the latent charge image. Given a developer mixture made of toner and carrier particles, this activation typically exists in a stirring of the developer mixture in which the toner particles are triboelectrically charged on [sie] the carrier particles. During the standby state of a developer station, the developer
30 contained therein is advantageously activated at predetermined intervals.

MARKED-UP COPY

The developer is then immediately ready for use when the developer station is returned from the standby state to the print operation state.

In an advantageous development, it is counted how often the developer has been activated during the standby state, and in the event that
5 the number or the total duration of the activations exceeds a predetermined threshold no further activations are implemented for the duration of the standby state. Given standby states of shorter duration the developer then always remains functionally ready, while given standby states of longer duration activations are foregone in order to protect the developer.

10 As was already mentioned above, both aspects of the invention preferred embodiment are closely related and can be combined with one another in an advantageous manner as in the illustrated advantageous developments. For example, in an advantageous development that comprises both aspects of the invention preferred embodiment the developer
15 is activated at predetermined intervals during the standby state of a developer station until the first regeneration criterion is fulfilled, whereupon no further developer activations are implemented in the developer station for the remaining duration of the standby state, and with the developer regeneration process ~~it is waited [sic] the process waits~~ until the developer station is
20 required for developing or until another developer station of the printer or copier starts a developer regeneration process.

On the one hand the developer is protected in this manner during a longer standby state; on the other hand, the print operation is not interrupted for a developer regeneration process as long as the developer station is found in a standby state, i.e. until it is not required for developing. The regeneration processes can thus be better temporally concentrated and the number of the interruptions of the print operation can be reduced.
25

~~For better understand of the present invention, in the following reference is made to the preferred exemplary embodiment shown in the drawings that is described using specific terminology. However, it is noted~~
30

MARKED-UP COPY

that the protective scope of the invention should not thereby be limited since such variations and further modifications to the shown method and the shown control device as well as such further applications of the invention as they are shown therein are viewed as typical present and future expert knowledge of a 5 competent average man skilled in the art. The Figures show an exemplary embodiment of the invention, namely

Figure 1 a block diagram that shows the components of a method according to a development of the invention,

10 Figure 2 a flow diagram that shows a method for evaluation of the toner discharge,

Figure 3 a flow diagram that shows a method for administration of states of a developer station,

Figure 4 a flow diagram that shows a method for standby administration,

15 Figure 5 a flow diagram that shows the temporal synchronization of developer regeneration processes given a plurality of developer stations of a printer,

20 Figure 6 a flow diagram that shows the integration of a method according to a development of the invention into a conventional method for controlling a printer, and

Figure 7 a section representation of a printer is [sic]

A printer 10 is shown in Figure 7 in a section representation. The printer 10 has an upper printing group 12 and a lower printing group 14 that are designed identically and whose components are designated with the 25 same reference characters. The printing groups 12 and 14 respectively have a photoconductor belt 16 that is electrically charged by a charging device (not shown in detail) and that is charged point-by-point via exposure by a character generator 18 for generation of a charge image.

MARKED-UP COPY

The photoconductor belt 16 runs past five developer stations 20, 22, 24, 26 and 28, of which only that with reference character 20 is shown in detail in Figure 7 and the remaining are symbolically represented by triangles. The developer stations 20 through 28 are respectively designated for 5 development of a color component of a color image. The color components are advantageously formed by the colors cyan, yellow, magenta, black and a spot color; however, they can also be any other color.

For generation of a color component of a print image, a charge image that corresponds to the color component is generated on the photoconductor 10 16 by the character generator 18 and this charge image is developed with color toner by the associated developer station. The toner image of the color component so obtained is transfer-printed onto an intermediate carrier (here in the form of a transfer belt 30) at a first transfer printing point 29. However, an intermediate carrier drum can also be used as an intermediate carrier, for 15 example. The residual toner remaining on the photoconductor 16 given the transfer printing is removed from the photoconductor belt 16 by a cleaning device 32. The photoconductor is subsequently re-charged, the charge image for a further color component is generated on the photoconductor 16 by the character generator 18, and is developed by the associated developer station 20, 22, 24, 26 or 28 and likewise transfer-printed onto the transfer belt 30, and in fact in such a way that the individual color components overlap into a multi- 25 color image on the transfer belt 30.

Maximally five one-color images in the aforementioned component colors are thus superimposed into a multi-color image (color image) on the transfer belt 30. The transfer belt 30 is then panned to a paper web 34 and the color image is transfer-printed from the transfer belt 30 onto the paper web 34 at a second transfer printing point 36. In the representation of Figure 25 7, the transfer belts 30 are shown in the state pivoted towards the paper web 34, in which the front side and the back side of the paper web 34 can be 30 printed simultaneously.

MARKED-UP COPY

The residual toner that remains on the transfer belt 30 after the transfer printing onto the paper web 34 is removed by a transfer belt cleaning device 38. The transfer-printed color images are then fixed on the paper web 34 in a fixing station 40.

5 Given a typical method for control of the printer 10, all developer stations 20, 22, 24, 26 and 28 are located in what is known as a "color standby state" during the print operation. During the color standby state, the developer stations 20, 22, 24, 26 and 28 are mechanically pivoted into an operating position on the photoconductor. All mechanical actuators of the
10 developer stations run with nominal parameters. Actuators for mixing devices such as paddlewheels, mixing dredgers and/or screws as well as actuators for magnet rollers and further functional rollers for development of the charge image belong to the mechanical actuators. Only the functional voltages (i.e. the voltages that are necessary for toner transfer between the developer
15 stations 20, 22, 24, 26 or, respectively, 28 and the photoconductor belt 16) are still connected, such that no toner transfer can occur. The developer station can be brought from this color standby state into the development operation in the shortest time period, typically less than 0.2 seconds.

20 The continuous mixing of the developer with a paddlewheel, a screw or the like is necessary (as explained above) in order to activate the developer. Depending on the composition of the print data, however, it can be necessary that a color component is only weakly represented for a longer sustained time. This leads to a prolonged low toner discharge from the developer station associated with the color component. When the developer is continuously
25 stirred given a prolonged low toner discharge, it is damaged in a relatively short time and allows only a poor print image quality. In particular the case can occur that a color component is not needed at all for a longer time period because the print data does not provide this color component for this time period. In this case the developer of the developer station (which is located in
30 color standby) is also continuously activated and therefore damaged or,

MARKED-UP COPY

respectively, subjected to an aging process. Moreover, the developer station is unnecessarily operated, which increases its wear.

The exemplary embodiment subsequently described shows a method for controlling the printer 10 that leads to a reduced wear of the developer and 5 of the developer stations 20, 22, 24, 26 and 28. This method is implemented with the aid of an electronic control device that is not shown in the Figures.

The significant components of a method for controlling the printer 10 according to a development of the invention preferred embodiment are shown in a block diagram in Figure 1. After a start in step 42, in step 44 the counters 10 BD and ts are initialized whose function is explained below. The controller subsequently proceeds to a toner discharge evaluation procedure 46 in which it is determined whether the toner discharge from the developer station to which this part of the controller corresponds has ~~lai~~ fallen below a predetermined value for a longer time period.

15 In the event that this is the case, a developer regeneration process 48 is started. In the event that this is not the case, the controller proceeds to a state administration 50 for the appertaining corresponding developer station. In the developer station state administration 50, it is checked whether the developer station has not been or will not be needed for a predetermined time 20 span. In the event that this is not the case, the controller returns to the toner discharge evaluation 46. However, in the event that this is the case the developer station shifts into the standby state in which all or at least a part of the mechanical actuators of the developer station are stopped, and the controller proceeds to the developer station standby administration 52.

25 During the standby administration 52 it is checked whether a color requirement exists for the color of the developer station, i.e. whether the developer station will be needed in the foreseeable future. If this is the case, the controller proceeds to step 54, in which the developer station is brought into the color standby state described above. Under the circumstances

MARKED-UP COPY

explained in detail below, the standby administration 52 can also start a developer regeneration process 48 from a standby state.

A flow diagram of the evaluation procedure 46 of the toner discharge is shown in Figure 2. After a start in step 56, the average toner discharge from 5 the appertaining corresponding developer station for a time interval of predetermined length is determined in step 60 during the print operation $[[()]]58[()]]$. The determined average toner discharge is compared with a threshold y in step 62. In the event that the average toner discharge is greater than or equal to the threshold y , a regeneration monitoring counter 10 (RÜZ) is set to 0 in step 64 and the controller proceeds to the developer station state administration 50 (see Figure 1).

In the event that the average toner discharge in step 62 was less than the threshold y , RÜZ is increased by a first increment $R1$ in step 66. In step 15 68 it is then checked whether RÜZ lies above a threshold x . In the event that this is not the case, the controller likewise proceeds to the developer station state administration 50. However, in the event that RÜZ has reached the threshold x in step 68, a first regeneration criterion is fulfilled. This first regeneration criterion indicates that the average toner discharge has been fallen below the threshold for a certain time duration. Given a longer 20 sustained low toner discharge, the developer in the developer station would be damaged. In order to prevent that, the developer regeneration process 48 (see also Figure 1) is accordingly started.

The normal print operation is initially interrupted in the developer regeneration process 48 (not shown in the diagrams). The character generator 18 (see Figure 7) generates an artificial charge image (i.e. a charge 25 image not provided in the print data) on the photoconductor 16 that is formed as a whole-area pattern with an areal coverage of 10% to 50%. The developed charge image is transfer-printed onto the transfer belt 30 at the first transfer printing point 29 (see Figure 7).

MARKED-UP COPY

In a manner different than given the typical transfer printing during the print operation, in a first embodiment variant the voltages and currents relevant for the transfer printing at the first transfer printing point 29 are connected such that only approximately 50% of the toner image is transfer-
5 printed from the photoconductor 16 onto the transfer belt 30. The transfer belt 30 is moreover moved forward (i.e. pivoted away) from the transport path of the paper web 34 so that no toner arrives on the paper web 34 from the transfer belt 30. Instead of this, the transfer-printed portion of the toner image is cleaned off of the transfer belt 30 by the transfer belt cleaning device 38.
10 The portion of the toner image that is not transfer-printed is cleaned from the photoconductor 16 by the photoconductor cleaning device 32 in a similar manner. Due to the transfer printing efficiency of approximately 50% at the first transfer printing point 29, the cleaning work is uniformly distributed on both cleaning devices 32 and 38.

15 In a second embodiment variant, the voltages and currents relevant for the transfer printing at the first transfer printing point 29 are connected such that between 75% and 100% of the toner image is transfer-printed from the photoconductor 16 onto the transfer belt 30. This (in comparison to the first variant) proportionally larger transfer printing lends itself [sic] when toner markings are generated on the photoconductor 16 and are analyzed for calibration of the electrophotographic components. For correct analysis of the toner markings it is important that the photoconductor on which the toner marker is generated is free of residual toner. When the transfer printing efficiency from the photoconductor onto the intermediate carrier is relatively
20 low in the developer regeneration process, the cleaning device 32 must clean relatively large amounts of toner from the photoconductor 16, such that potentially too much residual toner in order to be able to generate a reliable toner marker [sic] could still remain on the photoconductor 16 after a cleaning pass. In the second embodiment variant, a higher transfer printing efficiency
25 of 75% to 100% is therefore selected in the developer regeneration process.
30

MARKED-UP COPY

The remaining less than 25% of the pattern ~~[sie]~~ can then be thoroughly cleaned by the cleaning device 32 in a cleaning revolution.

In the developer regeneration process 48, an artificial or, ~~respectively~~, random toner discharge from the developer station is caused. Moreover, a 5 corresponding quantity of fresh toner is subsequently delivered into the developer station. ~~A damage~~ Damage to, an aging or, ~~respectively~~, a wear of the developer in the developer station is prevented by this artificial toner throughput.

10 To calculate the average toner discharge in step 60 of Figure 2, the number of pixels in the color corresponding to the developer station are added up using the print data, weighted with their inking level. This represents a simple and sufficiently-precise method for determination of the toner discharge.

15 In the printer 10 of Figure 7, the print data are additionally already stored in a page buffer (not shown) sometime before the point in time at which the image corresponding to these data is to be developed by the developer station.

20 A flow diagram of the developer station state administration 50 of Figure 1 is shown in Figure 3. After the start in step 70, the page buffer with the print data is evaluated in step 72. Using the print data in the page buffer, in step 74 it is established whether a color requirement exists for the ~~appertaining~~ corresponding developer station, i.e. whether print data are present that are to be developed with the color of the toner of the developer station. In the event that this is not the case, a counter ts is increased by an 25 increment dt in step 76. In step 78 it is then checked whether the counter ts is smaller than or equal to a threshold $tsmax$. In the event that this is the case, the controller leaves the state administration 50 in step 80. In step 80 the controller could, for example, return to the toner discharge evaluation 46; however, the precise connection of the individual method parts is not specified

MARKED-UP COPY

in detail. In any case, the toner discharge evaluation 46 and the developer station state administration 50 can run parallel to one another.

However, in the event that the counter ts has reached the threshold ts_{max} in step 78, in step 81 it is initially checked whether color requirements 5 exist for further colors of the print path. With regard to the printer 10 of Figure 7, this means that it is verified whether further developer stations of the same printing group 12 or, respectively, 14 are required. In the event that this is the case, in step 82 the controller starts the standby administration 52 (see Figure 1) for the appertaining corresponding developer station and shifts this 10 developer station into the standby state described above.

However, in the event that it was established in step 81 that no color requirements exist for all developer stations 20, 22, 24, 26 and 28 of the print path (i.e. printing group 12 or 14), in step 84 the standby administration 52 is likewise started and the developer station is shifted into the standby state. 15 However, in step 86 the electrophotography device of the print path is additionally deactivated. With regard to the printer 10 of Figure 7, this can occur, for example, when the paper web 34 is only simply printed (thus one of the printing groups 12 or 14 is not used). In this case, the electrophotography device of the printing group that is not required is shut down in order to 20 conserve its components, for example the photoconductor 16, the character generator 18, the cleaning device 32 etc.

Stated briefly, the steps 76 through 86 of the state administration 50 have the effect that a developer station is shifted into the standby state when it was not needed for a longer time period, namely when ts is greater than ts_{max} . It can then be assumed with some probability that the developer 25 station is also not needed for a further time period, such that it is worthwhile to shift it into the standby state in order to conserve its mechanical components.

When a color requirement for the appertaining corresponding developer station is established in step 74 of the state administration 50 of 30 Figure 3, the counter ts is set to 0 in step 88. In step 90 it is then checked

MARKED-UP COPY

whether the developer station is located in the standby state. In the event that this is not the case, the state administration 50 is left in step 92.

However, in the event that the developer station is located in the standby state, in step 92 it is checked whether the electrophotography device of the print path or, ~~respectively~~, of the printing group to which the appertaining corresponding developer station belongs is deactivated. In the event that the electrophotography device is deactivated, it is activated in step 94. In step 96 a color requirement is subsequently sent to the developer station standby administration 52.

10 The developer station standby administration 52 of Figure 1 is shown in a flow diagram in Figure 4. After a start in step 98, a standby counter BD is initialized in step 100. In step 102, the counter BD is increased by the increment dBD. In step 104 it is checked whether a color requirement exists for the appertaining corresponding developer station.

15 In the event that this is not the case, in step 106 it is checked whether the counter BD corresponds to a threshold r. In the event that this is not the case, the controller returns to step 102.

When the counter BD has reached the threshold r, the developer in the developer station is activated in step 108.

20 In step 110 the regeneration monitoring counter (RÜZ) is increased by a second increment R2 that can be different from the first increment R1 from the step 66 of Figure 2. In step 112 it is thereupon checked whether RÜZ is still smaller than the threshold x, i.e. whether the first regeneration criterion is fulfilled.

25 In the event that RÜZ is smaller than or equal to x in step 112, thus that a developer regeneration process is still not necessary, the controller returns to step 100. As long as no color requirement exists in step 104, the steps 100 through 112 are run through as described above. The developer is thereby activated at regular time intervals whose length is predetermined by the variable r (see step 108), whereby the developer is initially kept ready for use.

MARKED-UP COPY

If in step 112 it is established that RÜZ has reached the threshold x, i.e. the first regeneration criterion is fulfilled, in step 114 the developer station is panned away from the photoconductor 16. Although the first regeneration criterion is fulfilled in this state, the regeneration process 48 (see Figure 1) is 5 not started for the time being. Instead of this, the controller proceeds to the step 102. In step 102 the counter BD is newly incremented by the increment dBd so that it is now greater than r. This has the result that the counter BD in step 106 is always greater than r, and thus the controller cyclically executes the steps 102, 104 and 106 until a color requirement exists in step 104. In 10 particular no further activation of the developer is effected until further notice because the step 108 is no longer reached, whereby the wear and the aging of the developer is reduced.

In the event that a color requirement exists in step 104, in step 116 it is initially checked whether $BD \leq r$. In the event that this is the case, no further 15 activation of the developer is necessary. In step 118 the counter BD is then set to 0 and the developer station is shifted into the color standby state described above.

In the event that the counter BD in step 116 is greater than r, in step 122 the developer station is panned to the photoconductor 16 and the 20 developer is activated in step 120. The counter BD is set equal to 0 in step 124 and the developer regeneration process 48 is started.

As is to be learned from the flow diagram of Figure 4, in the standby state of the developer station a developer regeneration process 48 is delayed (in spite of fulfillment of the first regeneration criterion) until a color 25 requirement exists in step 104, i.e. until the developer station is actually needed again. This has the advantage that the print process does not have to be unnecessarily interrupted. Rather, in this manner it is possible to synchronize the regeneration processes of different developer stations with one another, i.e. to optimally temporally concentrate as is explained in detail 30 in the following under reference to Figure 5.

MARKED-UP COPY

Using a flow diagram, Figure 5 shows how the developer regeneration processes 48 of different developer stations can be synchronized with one another. The synchronization method begins in step 126 so that the regeneration process 48 is started for one of the five developer stations 20, 5 22, 24, 26 and 28 of the upper printing group 12 or of the lower printing group 14 (Fig. 7), for example via the step 68 in the toner discharge evaluation 46 of Figure 2. The various developer stations of the printing group 12 or 14 are characterized by a control variable or, ~~respectively~~, index i , $i = 1 \dots 5$ in the flow diagram of Figure 5. The counters RÜZ and BD of the i -th developer 10 station are likewise provided with the index i and thus become RÜZ i and BD i .

In step 128, for ~~the all~~ the developer stations $i = 1 \dots 5$ (for the upper or, ~~respectively~~, first printing group 12 (DW1) and for the lower or, ~~respectively~~, second printing group 14 (DW2)) it is checked whether the associated regeneration monitoring counter (RÜZ i) $\leq x_i - c_i$. This inequality 15 represents a second regeneration criterion for each developer station that is less restrictive than the first regeneration criterion, which generally has the form RÜZ i = x_i (see Fig. 2, step 68). At the threshold x the index i thereby indicates that different thresholds x_i can exist for the different developer stations. c_i is a positive number for each developer station i . The second 20 regeneration criterion is accordingly fulfilled when a regeneration process is in fact presently not yet necessary in the i -th developer station, however would be necessary in the foreseeable future, which is represented by the variable c_i .

In step 128 the controller branches into two branches [sic], namely: a 25 first branch that begins in step 130 and in which the chronological sequence of the regeneration processes of that printing group (DW1 or DW2) to which the developer station initiating the regeneration process belongs is established, and; a branch beginning in step 132 in which the order of the regeneration processes of the developer stations of the other printing group 30 (DW2 or DW1) is established.

MARKED-UP COPY

In the following, the developer stations 20, 22, 24, 26 and 28 are subdivided into the following four classes according to their current state:

1. The developer station that has initiated the regeneration process. It is characterized in Fig. 5 by $i = m$. $BDm = 0$ and $RÜZm = xm$ applies for it.

5 2. Developer stations that are located in the toner discharge evaluation 46 and fulfill the second regeneration criterion. Such developer stations are characterized in Fig. 5 by $i = n$. $BDn = 0$ and $RÜZn \geq xn - cn$ applies for them.

10 3. Developer stations that are located in the standby state, that fulfill the second regeneration criterion, but that do not fulfill the first regeneration criterion. Such developer stations are characterized in Fig. 5 by $i = b$. $BDb \leq rb$ and $RÜZb \geq xb - cb$ applies for them.

15 4. Developer stations that are located in the standby state, that fulfill the first regeneration criterion, however for which no color requirement exists. Such developer stations are designated with $i = w$. $BDw > r$ and $RÜZw > xw$ applies for them.

20 In the left branch of the flow diagram of Figure 5, after the step 130 the developer regeneration process for the m -th developer station (i.e. for the developer station initiating the regeneration process) is started in step 134 and $RÜZm = 0$ is set. Parallel to this, for all developer stations that fulfill the second regeneration criterion it is checked in step 136 whether $BDi = 0$. In the event that this is the case, these developer stations are developer stations of the second class that have been characterized with $i = n$. For the 25 developer stations of the second class, the developer regeneration process is started in step 138 with second temporal priority, i.e. immediately after the regeneration process of the initiating (i.e. m -th) developer station.

30 In the event that it is established in step 136 that $BDi \neq 0$, this developer station is located in the standby state and thus falls into the third or fourth class. So that a developer regeneration process can be implemented

MARKED-UP COPY

in such developer stations, these developer stations must initially be brought from the standby state into the color standby state. Since this can require some time, it is preferred to first implement the developer regeneration process for the developer stations of the first class and the second class, as is
5 shown in Figure 5. During the time required for this, the developer stations of the third class and the fourth class can then be brought from the standby state into the color standby state.

In step 138 it is additionally checked whether $BDi \leq r$. In the event that this is the case, no toner activation is required for the appertaining
10 corresponding developer station. The developer station thus belongs to the third class ($i = b$) and its developer regeneration process is implemented in step 140 with third temporal priority. Moreover, the variables or, ~~respectively~~, counters BDb and $RÜZb$ are set equal to 0 in step 140.

In the event that BDi is greater than r in step 138, the developer station
15 belongs to the fourth class (which is characterized by $i = w$). For it, in step 142 the toner is initially activated and BDw is set equal to 0. The developer regeneration process for these developer stations is subsequently started in step 144 with fourth (and thus least) temporal priority and the counter $RÜZw$ is set equal to 0. The temporal preference of the developer stations of the
20 third category relative to those of the fourth category is justified in that, given such developer stations of the fourth category, an additional toner activation is to be implemented that can be implemented while the end of the regeneration process of the developer station or developer stations of the third class is awaited.

25 The right branch of the flow diagram of Figure 5 is essentially identical with the left branch except that here no developer station of the first class exists, of which there is always only one and which was dealt with in the left branch. In particular the steps 146 through 154 of the right branch correspond exactly to the steps 136 through 144 of the left branch. In step
30 156 it is awaited [sic] until all developer regeneration processes are

MARKED-UP COPY

concluded. The controller subsequently proceeds to the toner discharge evaluation 46.

In Figure 6 a flow diagram is shown using which the integration of the exemplary embodiment described in Figures 1 through 5 into a known controller for a printer is explained. The controller begins in step 158 with the switching-on of the printer 10. In step 160, the printer 10 is located in a standby mode and waits for data. After print data have been received in step 162, in the steps 164/1, 164/2 and 164/3 a calibration process without toner discharge is implemented in developer stations 1 through 3. For reasons of clarity, only three developer stations are considered in the flow diagram of Figure 6 instead of the five developer stations per printing group of Figure 7.

The calibration in step 164 is a preparation mode into which the printer 10 is brought before the beginning of the print operation. Operating parameters are calibrated in the calibration step 164. A transient effect is thereby implemented for control loops for regulation of operating parameters (which, for example, concern the charging of the photoconductor belt 16, the discharging of the photoconductor belt 16, the toner concentration in the developer mixture or the inking). After the end of the calibration in step 164, all three developer stations are brought back into the color standby state in steps 166/1 through 166/3.

In step 168 it is waited [sic] until all three developer stations have assumed the color standby state. In step 170 the heating of the fixing station 40 (see Figure 7) is begun. In step 172 the printer 10 is found in the print operation in which print data exist. In the event that the print data are interrupted in the print operation, a short run-out begins. When the print data terminate for longer than the run-out time, the printer is halted in step 174. After the printer has been halted in step 176, the controller returns to step 160.

The toner evaluation 46 and the developer station state administration 30 50 run as independent processes in addition to the print operation (step 172)

MARKED-UP COPY

and are therefore executed separately in Figure 6. The developer station state administration 50 anticipatorily analyzes the page buffer of the print data and affects the method in that it shifts unnecessary developer stations into the standby state or, respectively, shifts said the developer stations from the 5 standby state into the color standby given the color requirement. The interaction of the developer station state administration 50 with the method from Figure 6 is generally symbolized by the loop "1".

The state administration 50 in particular monitors the print data during the print operation (step 172) and shifts one or more of the developer stations 10 1 through 3 into the standby state in steps 178/1 through 178/3 (according to the method described in Figure 3) when the counter ts has reached the threshold $tsmax$ (see Figure 3, step 78). This effect on the print operation is symbolically represented by the loop "1-a" in Figure 6. When a color requirements exists according to step 104 of figure 4, the developer stations 15 are retrieved from the standby state by the state administration 50 and brought into the print process again via the calibration (step 164) and the color suspension bridge (step 166).

Blank pages are typically printed during the calibration (step 164), i.e. charge images are generated that can be developed but not transfer-printed. 20 For example, in the course of the calibration toner markings can be printed that are not transfer-printed. However, in the typical calibration no whole-area toner patterns are generated on the photoconductor 16 as they are used in the developer regeneration process. This calibration is designated in Figure 6 as "calibration without toner discharge" (see step 164).

25 In the event that a developer regeneration process is pending after the end of the standby state, this is realized in that the calibration is implemented with toner discharge in step 164. In this manner the regeneration process can be linked in a simple manner with a printer state or, respectively, preparation mode that is provided anyway in the printer controller. Thus no new printer 30 state must be implemented for the toner regeneration.

MARKED-UP COPY

During the print operation (step 172), the toner discharge evaluation 46 can also establish whether the first regeneration criterion is fulfilled for a developer station that is not located in the standby state (see Fig. 2, step 68). In this case the print operation (step 172) is interrupted and the toner 5 regeneration process is implemented in that the calibration in step 164 is implemented with toner discharge without shifting the developer station into the standby state beforehand. Moreover, the toner discharge evaluation 46 communicates the necessity of the regeneration process to the developer station state administration 50, which then takes on the synchronization of 10 possible pending regeneration processes of the remaining developer stations according to Figure 5.

Although a preferred exemplary embodiment is shown and described in detail in the drawings and in the preceding specification, this should be viewed as purely exemplary and not as limiting the invention. It is noted that 15 only the preferred exemplary embodiment is shown and described, and all variations and modifications that presently or in the future lie within the protective scope of the invention should be protected.

MARKED-UP COPY

Reference list

- 10 ~~electrophotographic printer~~
- 12 ~~upper printing group~~
- 14 ~~lower printing group~~
- 5 16 ~~photoconductor belt~~
- 18 ~~character generator~~
- 20 through 28 ~~developer station~~
- 29 ~~first transfer printing region~~
- 30 ~~transfer belt~~
- 10 32 ~~photoconductor cleaning device~~
- 34 ~~paper web~~
- 36 ~~second transfer printing region~~
- 38 ~~transfer belt cleaning device~~
- 40 ~~fixing station~~
- 15 42 ~~start of the method~~
- 44 ~~initialization of the counters~~
- 46 ~~toner discharge evaluation~~
- 48 ~~developer regeneration process~~
- 50 ~~developer station state administration~~
- 20 52 ~~developer station standby administration~~
- 54 ~~color standby~~
- 56 through 68 ~~method steps of the toner discharge evaluation~~ 46
- 70 through 96 ~~method steps of the developer station standby administration~~ 50

MARKED-UP COPY

~~98 through 124 method steps of the developer station standby administration 52~~

~~126 through 156 method steps given the synchronization of the developer regeneration processes~~

5 ~~158 through 178 method steps given an implementation in a conventional control method~~

MARKED-UP COPY

Patent claims

WE CLAIM AS OUR INVENTION:

MARKED-UP COPY

ABSTRACT OF THE DISCLOSURE

In a method or system for controlling an electrophotographic printer or copier that has at least one developer station, a toner discharge from the developer station is detected during the print operation and a developer regeneration process is started when the detected toner discharge fulfills a predetermined first regeneration criterion. A charge image is generated on the photoconductor, the charge image is developed by the developer station, and the developed image is removed by a cleaning device without being transferred as printed onto a recording medium. New toner is introduced into the developer station. Also in accordance with the method or system for controlling an electrophotographic printer or copier that has at least two developer stations, during a print operation the print data is used to determine which developer stations are needed for printing of the data. In the event it is established that a developer station was not needed or will not be needed, the developer station is shifted into a standby state in which at least one part of mechanical actuators of the developer station is stopped.